



Accelerator R&D: Opportunities and Resources

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David Finley
At the Linear Collider Part of the
Public Presentation on Long Range Planning

October 23, 2003
Fermilab

- What's up now with Fermilab's LC R&D?
- What needs to be done in the next 6 years (pre-construction) and what resources are needed to get started?

Overview

- **LC Accelerator R&D budgets have been flat since FY01 (~\$2.5M) at this level we will never really be a serious “player” in an international arena in which FNAL wants to “bid to host” such a machine.**
- With this limited budget our strategy has been to focus effort in areas where we have some momentum, capabilities, and available people.
 - **Emphasis on NLC RF Structure development & civil/siting studies**
 - Very low level effort on TESLA continues, mostly looking at TESLA cost estimates. However SCRF R&D for other FNAL projects is relevant
- LC Accelerator R&D activities are now mostly in Technical Division
 - BD Accelerator Physics group has been redirected onto Run II.
 - Creation of an x-band power facility on-site has been suspended (\$,people)
 - Successful NLC permanent magnet development was stopped, because lead person is now working on the Tevatron
- **We should all realize that our current LC focus is pretty narrow**
- **If we do not find a way to increase the FNAL budget for LC R&D then it is unlikely that we will host this machine**

FNAL NLC Collaboration Responsibilities

- **X-Band Structures Production**

- Produce RF structures & strongbacks for High Gradient Testing at SLAC's NLCTA Facility
- Produce structures & strongbacks for Phase II of the NLC 8-Pack Project
- Industrialization of RF Structure Production (**the original mission**)

- **NLC Girder R&D**

- Develop girder design
- Construct prototype and conduct vibration and stability studies

- **NLC Site Studies (BD, FESS)**

- Conduct suitability studies for identified sites
- Develop civil construction cost estimates for identified sites
 - Develop cost comparisons between warm and cold machines

- **NLC structure fabrication consumes most of ~\$ 2.5 M LC budget**

NLC: RF Structures

- **NLC RF structure work is done in the TDRF Group**
- **Accomplishments**
 - Completed the IB4 RF structures factory
 - Finished FXB series structure production (no HOM waveguides)
 - Several of these have been tested at the SLAC NLCTA, they are as good (or bad) as structures produced elsewhere in the world
 - Procuring parts for fabrication of FXC series structures for the 8-pack test at SLAC. (these are the first “full featured” structures we will produce... ie they include HOM waveguides)
 - Started low level industrialization efforts (including SBIR support)
 - RF Design
 - Established significant RF design capabilities in the Technical Div
 - People (RF engineers)
 - Software and hardware purchases
 - Improved modeling/analysis techniques
 - eg Input/output coupler design for high gradient structures

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Accomplishments: IB4 RF Structure Factory



Small Vacuum Furnace

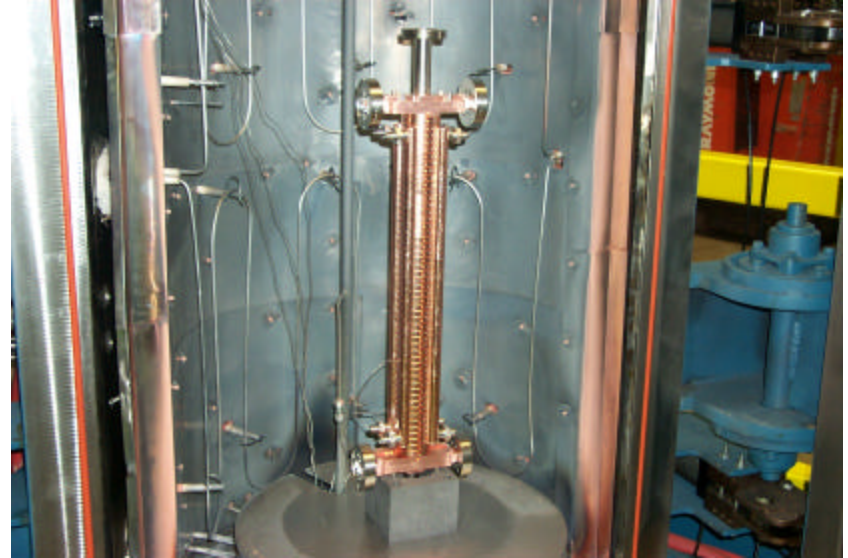
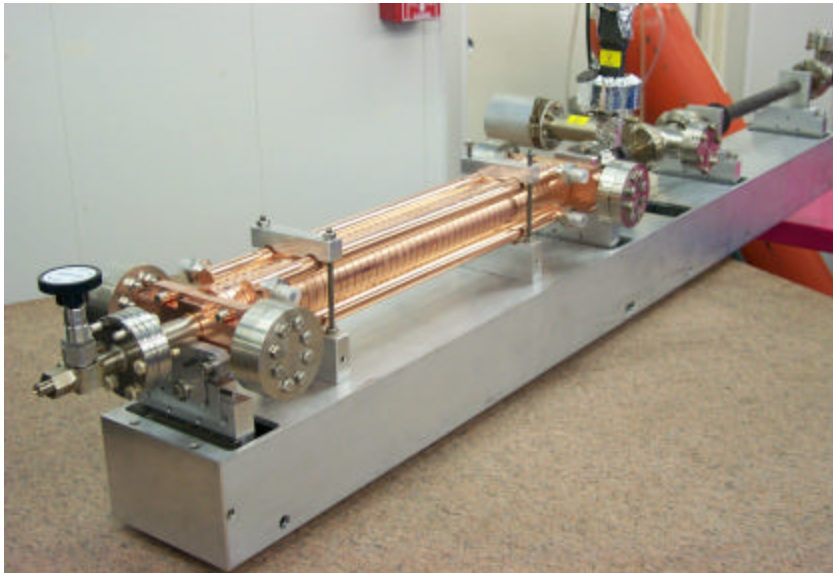
Small and Large Vacuum
Furnaces in Class 1000
Enclosure in IB4



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Accomplishments: RF Structures

- Structures Production
 - FXB Series Structures
 - Six structures were completed
 - Five of them have or will undergo high power testing at SLAC



Final assembly of FXB-004 in our large vacuum furnace.

FXB-002 mounted on strongback and ready for shipment to SLAC

Bob Kephart 9/25/03

Fermilab *Today* Monday, October 20, 2003

Fermilab sends RF structures to SLAC

R&D for the Next Linear Collider (NLC) is making progress. The two newest RF structures produced at Fermilab have arrived at SLAC for testing. The devices--stacks of precision-machined copper discs with holes in the center--transfer energy from a power source to a beam of electrons. The R&D focuses on manufacturing discs that achieve the highest acceleration per meter. "It took us, as part of the NLC Collaboration, four years to develop and produce this set of prototype discs," said Dave Finley, group leader of Fermilab's X-band (FX) accelerator structure team. Finley noted that the resources developed at Fermilab can be applied to either a room-temperature or a superconducting linear collider.

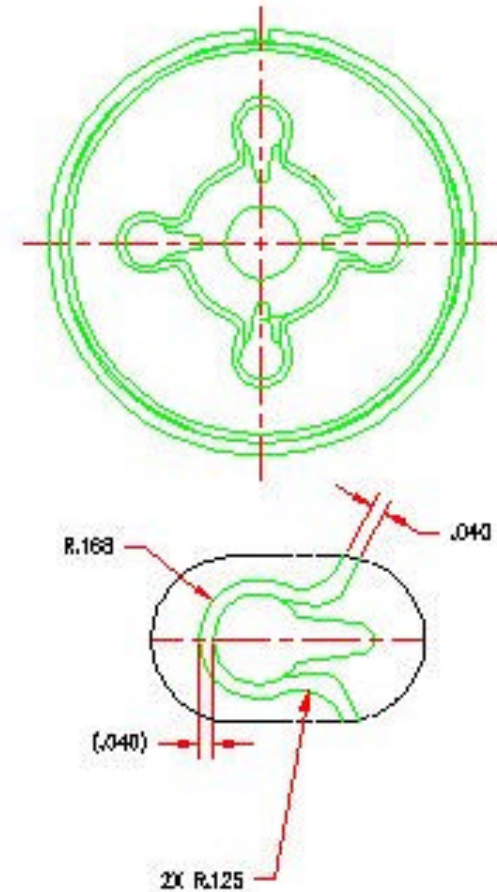


From left to right: Dave Finley (Group Leader), Harry Carter (Project Engineer), and Tug Arkan (Production Engineer) with one RF structure

Fifty-two discs make up one 60-cm-long structure. The NLC would use 18,000 structures. With help from Fermilab, LLNL, LBNL and KEK, researchers at SLAC are advancing accelerator design at their NLC Test Accelerator. While SLAC tests the FXB structures, Fermilab has already begun work on the FXC series. Finley quipped: "The NLC's motto seems to be: The better is the enemy of the good enough."

Accomplishments: Full Featured Structures

- Structures Production
 - FXC Series Structures
 - Parts procured for five structures



FXC Disk Design Details

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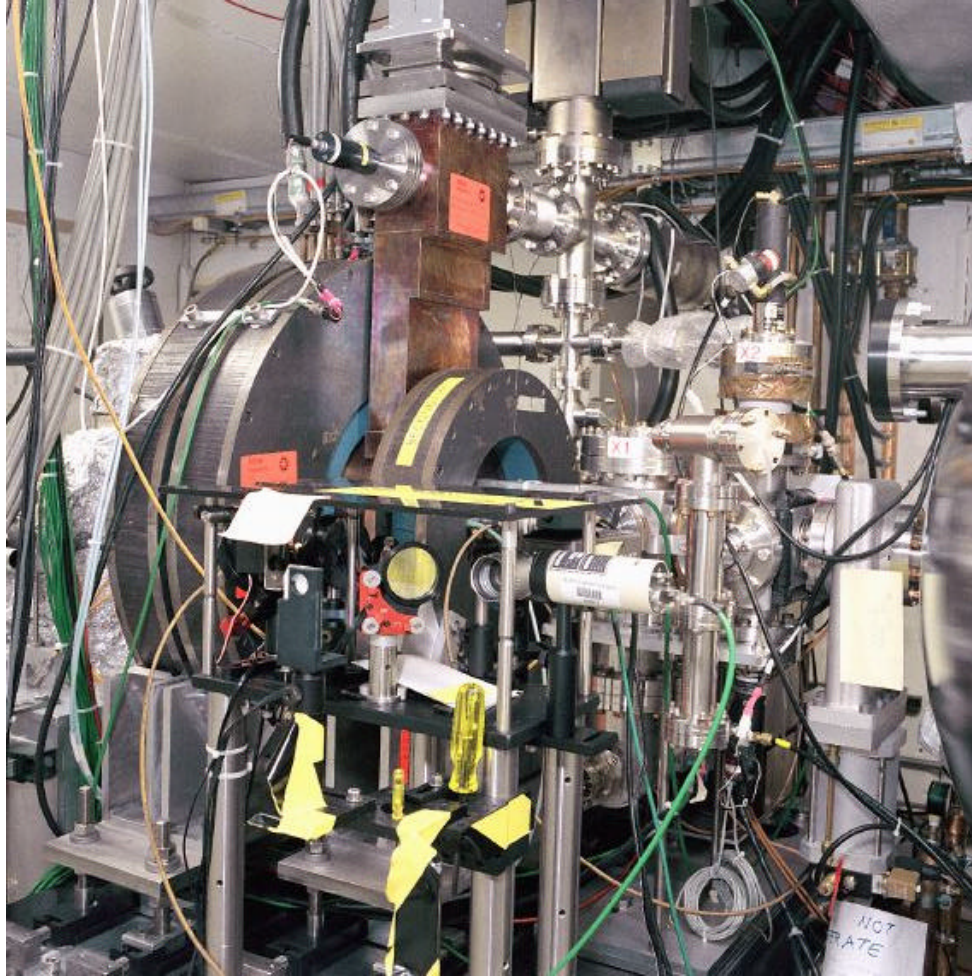
Linear Collider Site Studies

- Preliminary analyses of N-S and E-W sites near Fermilab FY01-02.
- FY2003 siting activities are being conducted under the auspices of the US Linear Collider Steering Group sponsored warm/cold evaluation:
 - SC linac **and** warm Linear Collider in a deep site near DeKalb, IL
 - Warm **and** SC Linear Collider in a bored tunnel at a California site
 - Analysis of incremental changes/costs for the alternatives.

SCRF R&D

- FNAL is currently doing very little Superconducting RF R&D in support of the TESLA proposal
- TD RF group is working on SCRF R&D for 2 FNAL projects that build SCRF capabilities relevant to a LC if the technology decision is for a cold machine
 - **CKM:** Collaboration with BD. Goal is to provide SC RF cavities (transverse kick mode) to be used to generate a separated charged K beam for the CKM experiment
 - **A0 3rd Harmonic cavity:** Goal is to provide a 3.9 GHz accelerating cavity to linearize high current electron pulses from the A0 photo-injector. (Note: TESLA would like us to build one of these for TTF-II also so there continues to be collaboration in this area)

FNPL (A0 Photoinjector)



RF Gun and focussing solenoids

NIU (Northern Illinois University) is involved with this activity.

<http://www-ap.fnl.gov/A0PI/a0pics.html>

FNPL (A0 Photoinjector)



SCRF module and
chicane dipole magnets

<http://www-ap.fnal.gov/A0PI/a0pics.html>

FNPL (A0 Photoinjector)



Spectrometer magnets,
plasma chamber, and
beam dump

<http://www-ap.fnal.gov/A0PI/a0pics.html>



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We are here ...

Fermilab LC Accelerator Opportunities

- Leadership
- LCRD with Universities
- Lots of beam physics, lots of engineering
- Development of Engineering Test Facility
 - Either warm or cold
- Many, many 20+ year career moves

Fermilab LC Resources

- People
 - Engineers and physicists
 - Contacts with other labs and with universities
- Money
 - ~\$3M/yr XBand R&D
 - ~ same on all other “related” R&D
 - ~ same in “nearby” institutions on “related” R&D
- Infrastructure
 - Excellent geology for LC
 - Photoinjector, RF Factory, SCRF

Fermilab LC Resources

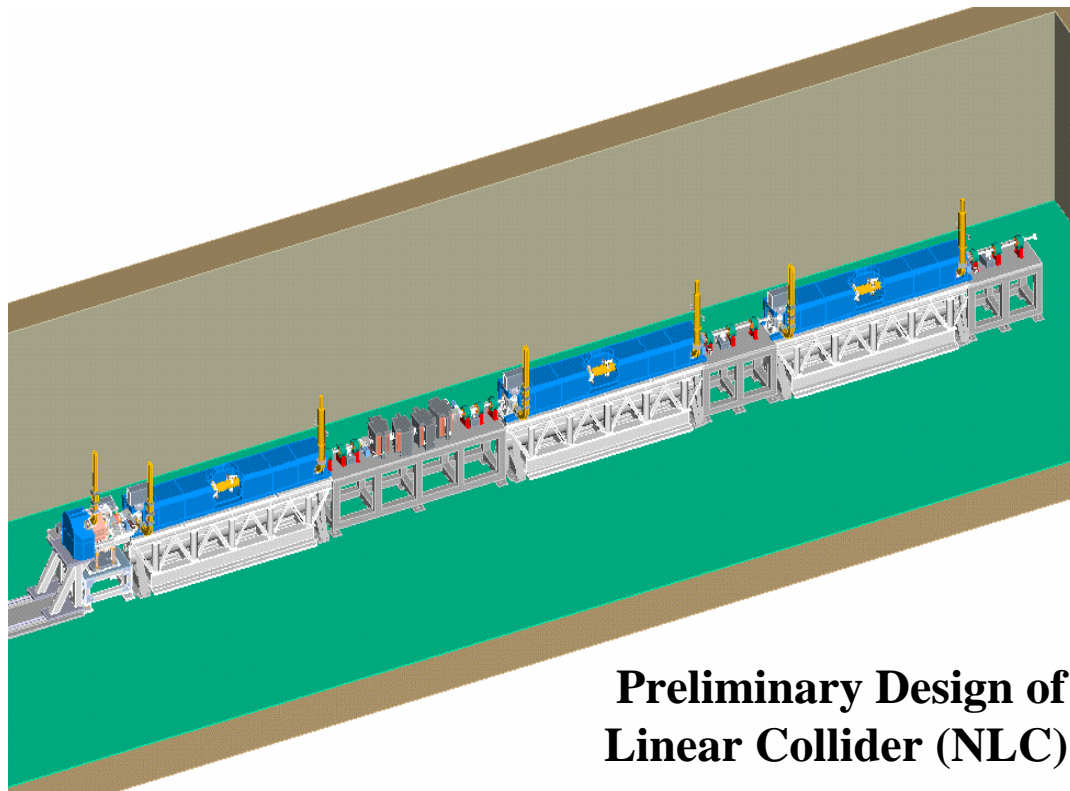
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* Not “Fermilab’s”
of course

What we need to do

- We must take a intellectual (Scientific, technical and management) leadership in the LC.
 - We want to get to 30% level in scientific and technical representation at the USLCWG by the end of FY04 and 50% by the end of FY05.
 - Fermilab should start working on a proposal (to be submitted to the USLCSG) for siting of the ETF (either warm or cold incarnations) at Fermilab.
 - Fermilab staff (Younger < 50!) needs to be brought on board with LC effort.
 - Fermilab University collaboration both US and International needs to be brought on board.
 - Last two are very important and needs public relation.

Preliminary Design of an Injector System for a Linear Collider (Warm or Cold) Engineering Test Facility (ETF)



We need to get ETF
Project back on track
with new knowledge and
with a plan to start
construction just after the
technology decision in
FY06.

**Preliminary Design of an Injector System for a Next
Linear Collider (NLC) Engineering Test Facility (ETF)**

Phase II Final Report

June 29, 2001

Shekhar Mishra 9/11/03

Resources

- Fermilab needs to focus on being the center of High Energy Physics beyond Run-II.
- Run-II related problem has overwhelmed Fermilab's scientific, technical and management staff.
- Now a new Run-II plan is in place. Significant fraction of this upgrade plan is to be completed by the end of FY05.
- By the end of FY05 significant fraction of people working on Run-II upgrade will become free.
- FY04-05 is the time for LC/ETF/Proton Driver(SCRf Linac) projects to get ready to take advantage of human resources that will be available at the end of FY05.
- We need about 20-25 FTE at the R&D and design stage of these activity.

Shekhar Mishra 9/11/03

Summary

- Fermilab needs to get visible in the LC effort by
 - Having and LC organization
 - Putting more effort into Accelerator Physics and Design
 - Propose and take a leadership role in ETF
 - We also need to put more effort in Detector R&D
- Fermilab needs to get the HEP collaborators on board with LC Accelerator and Physics
- Most importantly we need to prepare ourselves to Bid to host LC in Illinois near Fermilab.